Atmospheric radioactivity measurements at the SMEAR Estonia Station

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The SMEAR Estonia is a Station for Measuring Ecosystem-Atmosphere Relations (SMEAR). It is built on the same concept as the Finnish SMEAR stations¹ and belongs to the same measurement network. It is located in a hemiboreal forest at Järvselja, South-Eastern Estonia (58.2714 N, 27.2703 E at 36 m a.s.l.)². The Estonian University of Life Sciences runs long-term measurements on meteorological parameters, trace gases and fluxes at the station. Atmospheric aerosol and air ions measurements are deployed by the University of Tartu (UT).

Our main interest at UT lies in characterising atmospheric ions and aerosols, studying their connections to atmospheric new particle formation and cloud processes, and understanding the impacts of these processes on air quality, local weather and climate. Air ions are known to participate in forming atmospheric new particles³. Newly formed aerosol particles have the potential to modify cloud properties, once they reach big enough sizes via condensational and coagulational growth⁴. Air ions are primarily produced by the ionisation of air molecules, with the ionisation energy provided by natural radioactivity present in the atmosphere. The initial ionisation produces are subject to different dynamic processes, including charge transfer, clustering, coagulation and condensational growth⁵. At UT, we are launching a five-year project, starting from Jan. 2020, to investigate how atmosphere transforms the new-born air ions to climatically relevant aerosol particles. In order to get insights into the transformation process, atmospheric radioactivity measurements are crucial together with air ion and aerosol measurements.

In the lower troposphere, ionization of the atmospheric originates from the decay of radon and other radioactive nuclides in the air and the Earth's crust as well as cosmic radiation. In collaboration with the Finnish Meteorological Institute, we initiated atmospheric radioactivity measurements at the SMEAR Estonia. The total gamma radiation (50 keV to 1.3 MeV) is measured with a gamma radiation meter (RADOS RD-02L) (since June 2019). The atmospheric radon is monitored using a filter-based Geiger-Müller counter (since Nov. 2019), which is a one-counter
variation of an earlier design\textsuperscript{6}. Atmospheric radon concentration is determined based on deposited beta activity. Preliminary results show that SMEAR Estonia (mean gamma dose rate = 0.03 uSv/h, mean radon conc. = 2.5 Bq/m\textsuperscript{3}) has less ionization than SMEAR II station in Finland (mean gamma dose rate = 0.08 uSv/h, mean radon conc. = 2 Bq/m\textsuperscript{3}). The linkage of this observation to air ion properties is under progress.

References:
